Determinants and associations of threat-related cognitive biases:

Cognitive and neurophysiological perspectives

Guest editors: Tatjana Aue[1] and Hadas Okon-Singer[2]

[1]University of Bern, Switzerland

[2]University of Haifa, Israel

***Correspondence**:
Tatjana Aue
University of Bern
Institute of Psychology
Division of Experimental Psychology and Neuropsychology
Fabrikstr. 8
3012 Bern
Switzerland
tatjana.aue@psy.unibe.ch
Phone: +41 31 631 40 95

(Editorial)

Title: What characterizes and determines threat-related biases in fear and anxiety?

In pathological fear and anxiety, there are numerous examples of erroneous threat-related information processing. Among these are the social phobic's interpretation of the other person's encouraging smile as mockery; the spider phobic's unrealistic expectancy of encountering spiders and being attacked by these little animals; the obsessive-compulsive individual's incapacity to direct his or her attention away from supposedly contaminated objects; and the traumatized person's selective memory of disturbance-eliciting life events.

Processing biases are a hallmark of anxiety disorders. Pathological fear and anxiety are thought to be maintained by abnormal distribution of attention to external stimuli, atypical interpretation of situations, biased expectancy of events, and abnormalities in memory (e.g., Mathews, Mackintosh, & Fulcher, 1997). While pathological fear and anxiety are thought to be provoked or consolidated by such threat-related biases (Hirsch, Clark, & Mathews, 2006; Taylor & Rachman, 1994), these biases can, under certain circumstances, also be observed in healthy individuals (e.g., Amin & Lovibond, 1997; Davey, 1992; Öhman, Flyket, & Esteves, 2001). Threat-related cognitive biases may evoke powerful affective responses that are characterized by increased physiological arousal, inhibition of ongoing activities, and a change in individual priorities. Ideally, these responses are adaptive in the sense that they permit an individual to overcome obstacles and to accomplish the best possible outcome in a threatening situation (as is the case in healthy individuals). However, sometimes such fear and anxiety are inappropriate given the situation and, instead of enhancing life quality, they prevent individuals from living well and actively pursuing important goals. Rather than helping individuals to actively cope with a threatening situation, (sub)clinical types of fear and anxiety are thus maladaptive and restrictive. The delineation of neurocognitive and psychophysiological determinants and associations of such biases in fear and anxiety is therefore of high theoretical and societal interest.

Recent attempts have been made to understand the psychophysiological mechanisms underlying threat-related biases and the possible links between these biases (Aue & Okon-Singer, 2015; Hirsch et al., 2006; Williams, Watts, MacLeod, & Mathews, 1997). Understanding the neurophysiological and cognitive basis of different processing biases and the possible causal links between them is of fundamental theoretical importance. In the long run, such understanding will further pave the way to more effective neurocognitive treatments.

The aim of the current special issue is to provide a comprehensive survey of cutting-edge interdisciplinary investigations of processing biases in health and in anxiety disorders. The special issue includes original research papers, reviews, and theoretical opinion papers, all aimed at understanding the mechanisms subserving threat-related cognitive biases and possible shared processes between them. Contributions in this special issue describe research with different populations (healthy; those with phobia, general anxiety disorder, and subclinical anxiety) and methods (behavioral investigations, imaging studies, electroencephalography, and psychophysiology). The importance of individual differences (e.g., in trait anxiety, intolerance of uncertainty, worry, or neuroticism) with respect to threat-related processing biases is also discussed.

Following the official advertising and our invitation to contribute to the special issue's topic, we received a surprisingly high number of excellent papers and therefore decided to group them into two issues instead of a single special issue. The first special issue considers neurocognitive mechanisms modulating attention bias in anxiety (link to the other special issue). In this second special issue, we focus on (a) other forms of cognitive bias, to date understudied compared with attention biases, and (b) interactions between different types of cognitive bias.

1. Consideration of single cognitive biases

The special issue opens with a detailed neurocognitive examination of a posteriori covariation bias, a specific form of memory bias that describes the overassociation of specific events with specific outcomes. For instance, humans, phobic individuals in particular, have been shown to retrospectively overestimate the likelihood that fear-related stimuli were followed by a negative experience (e.g., de Jong & Merckelbach, 1991; Pury & Mineka, 1997). Here, Wiemer and Pauli (2016) showcase an ingenious study on spider phobia that identified functional connectivity patterns characteristic of increases or decreases in such an a posteriori covariation bias. Their results point to the fundamental role of communication between sensorimotor and visual areas for this kind of cognitive bias to arise.

Highly fearful and phobic individuals display not only well-known biases related to memory, attention, interpretation, and expectancies, but also significant perceptual distortions that may manifest as a size bias that, to date, has only rarely been studied. An interesting study by Leibovich, Cohen, and Henik (2016) showed that highly spider-fearful participants, in contrast to controls, present a size bias for spiders. Moreover, this size bias is influenced by both valence and self-relevance. Shiban et al.'s (2016) report relates to these observations by describing a significant reduction of size bias in spider phobia in response to a promising treatment involving exposure to virtual reality.

The mere exposure effect, an evaluative bias reflecting increased liking of repeatedly presented subliminal neutral stimuli (Zajonc, 2001), may also be of relevance for the investigation of the processing of threat-related information. While most research in the area has been conducted with neutral stimuli and/or healthy populations, Rinck and Becker (2016) present interesting data delineating how the mere exposure effect may be neutralized or even reversed in highly spider-fearful individuals who are confronted with spider pictures.

2. Consideration of causal influences between different cognitive biases

Recently, attention has been drawn to the fact that cognitive biases in clinical fear and anxiety may interact and that they only seldom operate in isolation (Aue & Okon-Singer,

2015; Hirsch et al., 2006; Williams et al., 1997). Sussman, Jin, and Mohanty (2016) provide an excellent review of top-down and bottom-up influences in threat-related perception and attention in anxiety. Their work stresses that top-down factors such as goals, prior knowledge, or expectancy have for too long been disregarded in research on attention deployment to and perceptual processing of threat, and that these factors deserve further investigation.

In order to determine causal influences of one bias on the other, one needs to experimentally manipulate one cognitive process and examine its influence on the other. Accordingly, the idea that biased prior expectancies might be responsible for deviations in attention deployment in phobia has been tested by Aue, Chauvigné, Bristle, Okon-Singer, and Guex (2016). Replicating an earlier behavioral finding (Aue, Guex, Chauvigné, & Okon-Singer, 2013) of missing evidence for expectancy influences on early orienting of attention – both in phobics and in non-fearful controls – our behavioral and psychophysiological (heart rate, pupil diameter, and respiration rate) data speak to the existence of specific threat detection mechanisms that are only minimally permeable to (experimentally manipulated) prior expectancies.

Another way to experimentally induce expectancies relies on changing memory traces via fear conditioning (and extinction) procedures, which thus refers to causal influences of memory processes on threat-related expectancies. Morriss, Christakou, and van Reekum (2016) present compelling skin conductance data suggesting that biased expectancies in fear extinction (i.e., expectancies that are overly resistant to fear extinction) may be the result of high intolerance of uncertainty.

Memory processes can also be related to attention deployment. Münch, Westermann, Pizzagalli, Hofmann, and Müller (2016) investigated the electrophysiological correlates of early visual processing of conditional stimuli, human faces, after fear conditioning and after extinction. In their original research, the authors additionally introduced top-down instructions in order to vary the degree of self-relevance of the conditional stimuli and investigated

whether this type of top-down contextual information can successfully modulate fear conditioning effects. Attention, as indexed by early brain responses, was particularly sensitive to self-relevant, non-extinguished conditional stimuli. Apart from showing memory influences on attention deployment in a more general sense, these results thus underscore the importance of the significance of the to-be-encoded material when building memory traces. The causal impact of another memory process on attention deployment is nicely illustrated in Sari, Koster, Pourtois, and Derakshan's (2016) study that showed convincing effects of working memory training on attentional control (and levels of trait anxiety) by the use of behavioral and electrophysiological (resting state EEG) measures.

However, fear-relevant biases in attention may not only be affected by specific memory processes; the reverse causal influence is also imaginable. Indeed, using skin conductance, Hur, Iordan, Berenbaum, and Dolcos (2016) provide strong evidence for the determinative character of an individual's focus of attention on the establishment of memory traces in fear conditioning. Their study additionally examined the influence of neuroticism, cognitive load, and contingency awareness on conditioning. Among other things, the authors found the impact of attentional focus to be most prominent in individuals characterized by both high neuroticism and high contingency awareness.

The special issue concludes with reflections on phenomena that, though related to anxiety disorders, may be worth being considered apart from them. Hezel and McNally (2016) review cognitive biases (in attention, interpretation, and memory) and other cognitive deficits in obsessive-compulsive disorder, and Davey and Meeten (2016) evaluate the role of these and other cognitive biases in perseverative worry bouts. The authors further point to similarities and divergences of cognitive peculiarities in obsessive compulsive disorders and pathological worry on the one hand and different types of anxiety disorders on the other. It becomes evident that some characteristics might be transdiagnostic in nature, while others are more specific to a particular disorder. Notably, both papers close with hypotheses about the associations between cognitive biases and discuss causal influences that need to be tested in future research. In addition, both groups of authors point to the lack of

neurophysiological investigations regarding cognitive distortions related to their topic of choice. Undoubtedly, further studies are needed to identify general versus disorder-specific neurocognitive mechanisms underlying different forms of cognitive bias and their interplay.

In sum, this unique collection of papers delineates promising and intriguing research avenues. We hope that the special issue may inspire new exciting research projects that will further our understanding of the neurophysiological and cognitive mechanisms implicated in threat-related information processing – in health as in disease.

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